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WORKSHOP ON FUTURE OPPORTUNITIES THROUGH GAAS ON
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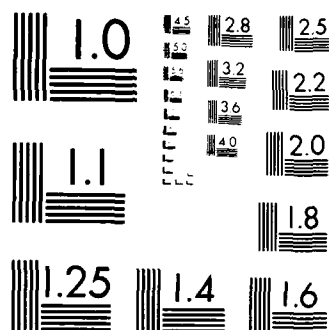
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Meeting, agenda, attendees, discussion topics

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The workshop was attended by about 110 researchers who are actively involved, in one phase or another, with GaAs on Si and related problems. The format of the workshop was such that there was ample opportunity for spontaneous discussions in subjects ranging from materials growth to potential systems that may be possible. The enclosed program details and the list of attendees should provide a sufficient account of what went on at the workshop.

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Final Report
Workshop on Future Opportunities
Through GaAs on Silicon
June 18-19, 1987, Marina del Ray, CA

H. Morkoc



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10 June 1987

Final Detailed Program

TECHNICAL PROGRAM

WORKSHOP ON FUTURE OPPORTUNITIES THROUGH GaAs ON SILICON

18-19 June 1987

Marina del Rey, California

Thursday morning: 18 June 1987

7:30-8:30 Continental Breakfast, Dining Room, Marina del Rey
Marriott Hotel

8:30-9:00 Registration (Lobby, Marriott Hotel)

9:00-9:05 Welcoming Remarks: Prof. Hadis Morkoc

9:05-9:50 Plenary Session:

A. Asch, "Why GaAs/Si"

D. Shaw, "What We Have Really Accomplished"

Note: Plenary speakers will tell us what GaAs/Si technology is all about, where we are now, where we are going and what the technology is likely to lead to if successful in application to integrated circuits and systems. They should also recount briefly the history of GaAs/Si, with reference to other lattice mismatched semiconductor materials systems, development of hetero-epitaxial materials and devices, in general, and particularly of III-V heterostructures on silicon.

SESSION I: GROWTH ISSUES:

9:50-10:10 I(a): Moderator: D. Shaw (T.I.)

"What Questions Have We Answered in GaAs/Si Epitaxy and Where are We Headed?"

(i) Fundamental Physics of Hetero-epitaxy

(ii) Basic Limitations

Speaker: S. Wang (U.C. Berkeley)

Audience Participation

G. Turner (Lincoln)
T. Lee (Kopin)
C. Itoh (FMI)
P. Norris (GTE)

10:10-10:40 I(b): Moderator: L. Schowalter (RPI)

"Are the Present Surface Preparation Methods Adequate?"

Speaker: Paula Grunthaner (JPL)

(i) Planar Growth

(ii) For patterned growth or selective epitaxy. Thermally grown oxides (thermal desorption and chemical desorption, pseudo-in-situ removal).

(iii) Speaker: Paula Grunthaner
How clean the surfaces are, potential contamination of epi-layer during growth.

DISCUSSION PERIOD: 20 minutes of total time for I(b). (Directed by Moderator, assisted by speakers seated at table facing audience, next to podium.

NOTE: In each major session, the speakers together with the moderator will serve as focus of a panel discussion with audience.

Panel

D. Biegelsen (Xerox)
P. Grunthaner (JPL)
F. Allen (UCLA)
F. Grunthaner (JPL)
D. Streit (TRW)
L. Schowalter (RPI)

10:40-11:10 I(c): Moderator: L. Schowalter (RPI)

"Epitaxial Wafer Properties and Their Relation to Processing/Production Issues"

Speaker: G. Turner (Lincoln Labs): (10 minutes)

MBE/MOCVD Growth as pertains to:

- (i) wafer size
- (ii) throughput, wafer cost
- (iii) compatibility with potential processing techniques
- (iv) wafer bowing, cracking, residual strain, dislocations, oval and large structural defects.

DISCUSSION PERIOD: 20 minutes of total time for I(c)

Audience

A. Y. Cho (AT&T Bell Labs)
C. Tu (AT&T Bell Labs)
G. Turner (Lincoln)
J. Lee (Kopin)
M. Scott (Kopin)
J. Salerno (Kopin)
J. Posa (Crystal Spec)
J. Fan (Kopin)
S. Severin (UET)
R. Lum (AT&T Holmdel)

"Growth on Patterned Wafers Selective Area Growth
CaF₂/GaAs Issues"

Speaker: To be chosen by Moderator
(possibly S. Wang).

11:10-11:40 Moderator: L. Schowalter (RPI)

Speakers: R. Matyi (T.I.)
J. Pinter (Ford Aerospace)
C. Tu (At&T Bell)

Issues:

- (i) Special cleaning procedures
- (ii) Special growth requirements
- (iii) Effect on hydrogen
- (iv) Effect of Ga, Al, etc. on underlying Si devices (threshold voltage shifts, etc.)
- (v) Growth over poly, SiO₂ and Si₃N₄.
- (vi) Selective etching vs. selective epitaxy.

OPEN DISCUSSION: Time allowed by Moderator

12:00-1:00 Luncheon

Thursday Afternoon

SESSION II: CHARACTERIZATION ISSUES:

1:10-1:30 II(a) Moderator: A. Jordon (AT&T)

"Overview: Characterization Techniques
Presently Employed in GaAs/Si Materials" (What
are the relevant techniques and their strengths
and limitations; possible new approaches
needed for GaAs/Si materials.)

Speaker: Ross Briegelsen or D. Beige Isen
(Xerox, PARC)

1:30-1:50 II(b) Moderator: A. Jordan (AT&T Bell)

"Structural Analysis by Transmission Electron
Microscopy"

Speaker: E. Weber and Z. Liliental-Weber
(UC Berkeley): 10 minutes

DISCUSSION PERIOD: 10 minutes of total time for II(b)

NOTE: E. Weber (Berkeley), Z. Liliental-Weber (Berkeley) and F.
Ponce (Xerox) should be on panel or in the audience. Also J. H. Mazur
(USC), J. Brown (AT&T), and A. E. Blackeslee (SERI).

1:50-2:00 II(c) Moderator: A. Jordan (AT&T Bell)

"Structural Analysis by X-Ray Diffraction"

Speaker: H. Zabel (University of Illinois)
10 minutes

2:00-2:30 II(d): Moderator: A. Jordan (AT&T Bell)

"Interfacial Analysis, What Can the Following
Methods do for GaAs/Si Towards Devices and
Circuits?"

STEM: "Scanning Tunneling Electron
Microscopy of GaAs/Si"

Speaker: W. Kaiser (JPL): 5 minutes

RHEED: "Reflection Electron Diffraction at
GaAs/Si"

Speaker: S. Batra & P. Cohen (Univ.
of Minn.): 10 minutes

2:30-2:40 DISCUSSION PERIOD: 10 minutes of total time for II(c)

NOTE: R. Bean (Ford Aerospace), A. Macrander (AT&T), D. Neumann (NBS), and C. Sparks (Oak Ridge) should be on the panel and speak if they wish. Also J. Ahearn (Martin Marietta and C. Litton (Avionics Lab).

DISCUSSION PERIOD: During Coffee Break

2:30-3:00 Coffee Break (Coffee and Refreshments served in Classroom).

SESSION III: UNIQUE PROCESSING AND DEVICE APPROACHES:

3:00-3:20 Moderator: B. Murphy (AT&T Bell)

"Can Si Processing Lithography be Used for GaAs Devices on Si?"

Speaker: A. Saxena (RPI): 20 minutes

"Special Requirements for GaAs/Si Processing" and "Characterization of Confined Area GaAs/Si Growth"

Speakers: T. Kamins/J. Adkisson, H-P Stanford
20 minutes

"Ion Implantation"

Speaker: S. Pearton (AT&T): 10 minutes

"Annealing, In-situ, Ex-situ"

Speaker: N. Chand, (AT&T): 10 minutes

OPEN DISCUSSION: Time allowed by Moderator (approx. 20 minutes)

Panel Members:

W. Oldham (Berkeley)

J. Salerno (Kopin)

M. Feng (FMI)

J. Amano (H-P)

S. Shichijo (TI)

DISCUSSION PERIOD: Time allowed by Moderator (approx. 20 minutes)

- (i) Accomplishments to date
- (ii) Major problems
- (iii) Potential Solutions
- (iv) Eventual Limitations
- (v) Effects of defects
- (vi) Applications & reliability (Nomardi, G.E.)

Panel

A. Y. Cho (AT&T)
H. T. Yuan (TI)
M. Feng (IMI)
H. K. Choi
H. L. Hung (COMSAT)
M. Namordi (GTE)

5:25 Break for Supper, End of Day

(Continuation of Session IV, HBT's & Optical Devices, Friday,
morning)

Friday morning: 19 June 1987: 8:45 a.m.

SESSION IV: DISCRETE DEVICE ISSUES (continued)

IV(c): Moderator: G. Witt (AFOSR)

8:45-8:55

"HBT-type Devices"

Speaker: H. T. Yuan (TI): 10 minutes

DISCUSSION PERIOD: Time allowed by moderator (approx. 15 minutes)

"Same Issues for HBT's as for FET devices and in
addition consider:

Speaker: T. Smith/H. Huang (COMSAT): 10 min.

"Substrate Requirements"

Speaker: A. Jordan (AT&T): 10 min.

DISCUSSION PERIOD: 20 minutes of total time for V(a)

Issues:

- (i) Microwave losses
- (ii) Low substrate resistivity
- (iii) Wafer supply
- (iv) Wafer warpage
- (v) Wafer fracture strength, GaAs vs. Si.
- (vi) Substrate wafer breakage & yield
consideration
- (vii) Cracking of epitaxy on Si
- (viii) Cracking of epitaxy on Si
- (ix) Possible solutions through selective epitaxy
and separation of device areas
- (x) Questions of thermal expansion differences

Audience/Panel

T. Smith (COMSAT)
H. Kim/M. Feng (FMI)
N. Cirillo (Honeywell)
S. Shichijo (TI)
A. Jordan (AT&T)
W. Tseng (NRL)
J. King (AFWAL)

10:45-11:00 Coffee Break

SESSION VI: FOCUSING ON THE APPLICATIONS OF GaAs/Si IC's:

VI(a): Moderator: J. N. Cast (Ford Aerospace)

11:00-11:20 "Overview of Functional Integration for Both
Electronic and Optoelectronic IC's"
Speaker: L. Chall (Ford Aerospace): 20 minutes

HOLD DISCUSSION FOR LATER

11:20-11:30 "Integration for VLSI"
Speaker: C. Hu* (Berkeley): 10 minutes
*Will not attend

DISCUSSION PERIOD: Time allowed by Moderator (approx. 15 min.)

Experts

L. Chall (Ford Aerospace)
B. Murphy (AT&T)
H. T. Yuan (T.I.)
T. Kamins/J. Adkisson (H-P)
A. Asch (Ford Aerospace)
P. Ko (Berkeley)
E. Gertner (Rockwell)
A. Saxena (RPI)
G. Rabanus (AFWAL)

11:45-1:00 BREAK FOR LUNCH (Luncheon arranged for continued
discussion in hotel dining room.)

Friday Afternoon

SESSION VI: FOCUSING ON APPLICATIONS OF GaAs/Si IC's (continued):

VI(a) Moderator: J. N. Cast (Ford Aerospace)

1:00-1:15 "Impact of GaAs/Si on Si VLSI"
Speaker: A. Saxena (RPI): 15 minutes

1:15-1:35 "VLSI Design with GaAs and Si"
Speaker: B. Murphy (AT&T): 20 minutes

DISCUSSION PERIOD: Time allowed by Moderator (approx. 30 min)

VI(b) Moderator: J. N. Cast (Ford Aerospace)

1:35-1:45 "Integration for Detectors/Focal Plane Arrays"
Speaker: K. Zanio (Ford Aerospace): 10 min.

1:45-1:55 "Integration for Detectors/Focal Plane Arrays"
Speaker: E. Gertner (Rockwell): 10 min.

DISCUSSION PERIOD: Time allowed by Moderator (approx. 20 min.)

Expert Panel

Same members as for VI(a) above

2:00-2:20 COFFEE BREAK

SESSION VII: OPTOELECTRONIC IC's AND OPTICAL INTERCONNECTS:

Moderator: J. C. Fan (Kopin)

2:00-2:30 VII(a) "Overview of IC's and Optical Interconnects"
Speaker: F. Leonberger (UTRC) and/or
J. Goodman (Stanford): 10 min.

2:30-2:40 VII(b) "Monolithic GaAs/Si Integration for Optical
Interconnects"
Speaker: H. K. Choi (Lincoln Labs): 10 min.

OPEN DISCUSSION: Time allowed by Moderator (approx. 20 min)

Panel Members

J. Goodman (Stanford)
H. Choi (Lincoln)
J. Ballantyne (Cornell)
K. Lau (ORTEL)
A. Yariv (Caltech)

SESSION VIII: REFLECTIONS AND CLOSING REMARKS

3:00-3:30 Moderators: H. Morkoc or C. Litton

Commentary

B. Murphy
A. Saxena
T. Kamins/J. Adkisson
L. Chall
D. Shaw

3:30- FINAL ANNOUNCEMENTS, WORKSHOP CONCLUDES

GaAs/Si WORKSHOP

18-19 June 1987, Marinas del Rey, California

SESSION MODERATORS

Session No.

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79	Saxena	Arun N	RPI	Center for Integrated Electronics	Troy	NY	12180 3590	(518) 270 6032
80	Schaus	Christian	AFWAL/UNM	EECE L215 D - Univ of NM	Albuquerque	NM	87131	(505) 277 1358
81	Schwallier	Leo J	RPI		Troy	NY	12181	(518) 276 6435
82	Shaw	Don W	Texas Instruments	P O Box 655936, MS 147, 08070	Dallas	TX	75265	(214) 995 4788
83	Shichijo	Sam	Texas Instruments	Cirral Research Lab P O Box 655936/MS134	Dallas	TX	75265	(214) 995 5510
84	Shin	Soo H	Rockwell Science Center	1049 Camino dos Rios	Thousand Oaks	CA	91360	(805) 373 4133
85	Smith	Thane	COMSAT Labs	22300 Comsat Drive	Clarksburg	MD	20871	(301) 428 4501
86	Speckman	Dorina	Aerospace Corporation	M2 244 P O Box 92957	Los Angeles	CA	90009	(213) 336 9399
87	Springthorpe	A J	BNR	P O Box 3511 Station C	Ottawa, Ontario	CANADA		(613) 726 4417
88	Streit	Dwight	TRW	One Space Park	Redondo Beach	CA	90278	(213) 536 8696
89	Tu	Charles W	AT&T Bell Labs	600 Mountain Ave - Rm MH 7B 410	Murray Hill	NJ	07974 2070	(201) 582 3416
90	Turner	George	MIT Lincoln Lab	244 Wood St. C-130	Lexington	MA	02173 0073	(617) 863 5500
91	Van der Ziel	Jan P	AT&T Bell Labs	600 Mountain Ave - Rm 7A 221	Murray Hill	NJ	07974	(201) 582 6935
92	Vasudev	Prahalad	Hughes Research Labs	3011 Malibu Canyon Rd	Malibu	CA	90265	(213) 317 5134
93	Wang	S	Univ of Ca	EE Dept	Berkeley	CA	94720	(415) 642 4134
94	Weber	F R	Univ of Ca Berkeley	Hearst Mining Building	Berkeley	CA	94720	(415) 642 0205

WORKSHOP on GaAs on Si - ATTENDANCE LIST

No	Last Name	First Name	Affiliation	Address	City	State	Zip	Telephone
95	Westergren	Mark	USAF	AFWL/ARBF	Kirtland AFB	NM	87117-6008	(505) 844-0166
96	Witt	Gerald	U.S. Air Force	AFOSR/NE	Bolling AFB	DC	20332-6448	(202) 767-4931
97	Wolfson	Robert G.	Spire Corp.	Patriots Park	Bedford	MA	01730	(617) 369-6132
98	Wong	Simon	Cornell Univ.	408 Phillips Hall	Ithaca	NY	14853	(607) 257-7752
99	Wood	Colin	GEC		Wembley	ENGLAND		01-9089552
100	Yanof	Arnold W.	AT&T Bell Labs	600 Mountain Ave - Rm 2A 330	Murray Hill	NJ	07974	(201) 582-6755
101	Yu	Anthony	Cornell Univ.	Bard Hall, Dept. of Materials Science	Ithaca	NY	14853	(607) 277-2897
102	Yuan	James	Texas Instruments	7131 Birchwood Dr.	Dallas	TX	75240	(214) 995-4339
103	Zabel	Hartmut	Univ of Illinois	Dept. of Physics-1110 W. Green St.	Urbana	IL	61801	(217) 333-2514
104	Zanlo	Ken	Ford Aerospace	Ford Rd.	Newport Beach	CA	92260	(714) 720-7707

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